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Commatarcha galicicae Tokár & Srnka, sp. nov., and a genus new for Europe (Lepidoptera, Carposinidae)

Zdenko Tokár[1], Ľubomír Srnka[2], Marko Mutanen[3]

1 *P. J. Šafárika 11, SK-92700 Šaľa, Slovakia; zdeno.tokar@gmail.com*

2 *Školská 752/9, SK-97242 Lehota pod Vtáčnikom, Slovakia; lubo@lemas.sk*

3 *Ecology and Genetics Research Unit, P.O. Box 3000, FI-90014 University of Oulu, Oulu, Finland; marko.mutanen@oulu.fi*

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Abstract. *Commatarcha galicicae* Tokár & Srnka, **sp. nov.** is described from specimens taken in two south-eastern European localities, the Galičica Mountain in North Macedonia, and Dubova in Banat, Romania. The new species belongs to the genus *Commatarcha* Meyrick, 1935, which is new for the European Lepidoptera fauna. It resembles some Asian species from this genus and also the American species *Bondia comonana* (Kearfott, 1907) in external characters. In the genitalia of both sexes, it is similar to *C. oresbia* Diakonoff, 1989 but differs markedly in the colour and pattern of the forewing. The immature stages of the new species are unknown. Colour photographs of the adults and of the habitat are included with illustrations of the female and male genitalia.

Introduction

The family Carposinidae is widespread on all continents, with approximately 290 described species in 32 genera, rich in the Oriental and Australian regions, and with remarkable diversity on some island groups (e.g. Hawaii, Macaronesia) (Diakonoff 1989; Ponomarenko 1999). In Europe, only the one genus *Carposina* Herrich-Schäffer, [1854] with seven species has been known hitherto (Karsholt and Nieukerken 2017). Five of these are endemic, described from Madeira and the Canary Islands. Only two species are known from continental Europe: *C. berberidella* Herrich-Schäffer, [1854], and *C. scirrhosella* Herrich-Schäffer, [1854]. Species from the family occurring in the Palaearctic region were revised by Diakonoff (1989). The North American species were reviewed by Davis (1969).

In late June 2016, while surveying the nocturnal Lepidoptera fauna of the Galičica Mountain in North Macedonia, the second author found two females of an unknown species at elevations between 1500–1600 m. A few years later, in July 2021, he was successful in collecting additional specimens of the species, two males and two females, at the same locality. A detailed study of the specimens by the first author showed that they represent a hitherto undescribed species in the genus *Commatarcha* Meyrick, 1935. After the first revision of our article, we received information from Peter Buchner that the brothers Zoltán and Sándor Kovács had found two specimens of a species

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unknown to them near the village of Dubova in south-western Romania also in 2021. After studying the adults and the female genitalia slide, we concluded that they belong to our new species.

The genus *Commatarcha*, with *C. palaeosema* Meyrick, 1935 as the type species, consists of 15 currently known species that are distributed in the Eastern Palaearctic, most of them in China (Li 2004; Qian and Li 2018). The closest relative to our new species in male and female genitalia is *C. oresbia* Diakonoff, 1989, a species found in the mountains of north-west Pakistan. This species is also geographically closest to our new species. In external appearance, the new species resembles several Chinese *Commatarcha* species, e.g. *C. acidodes* Diakonoff, 1989, *C. convoluta* Li, 2018, *C. fanjingshana* Li, 2004, and the American species of the genus *Bondia* Newman, 1856, *B. comonana* (Kearfott, 1907). American *Bondia* species are morphologically very close to *Commatarcha* species, indeed closer than to the Australian *Bondia nigella* Newman, 1856, the type species of its genus.

Materials and methods

All of the examined specimens were taken as adults, having been attracted to light. The genitalia were dissected following the usual procedure for small Lepidoptera (Robinson 1976) except that three preparations of the paratypes were temporarily stored in glycerol in small plastic vials. The drawings of the genitalia were made with Indian ink and water-soluble paint on transparent sheets of drawing paper. Photographs of the adult and the type locality were taken using digital cameras Canon PowerShot G11 and Panasonic Lumix DMC-LS85. A Nikon D 3100 camera, a Nectaris stereomicroscope with a microshift and a 4× planachromatic lens were used to photograph the heads.

Molecular analysis

We sent a leg of one North Macedonian specimen of the new species together with legs of two specimens of *Carposina* species (*C. berberidella*, *C. scirrhosella*) for DNA barcoding to Shandong Normal University (China) and COI barcodes were obtained from the tissue of these legs. Protocols for total DNA extraction and mitochondrial COI gene amplification followed Liu and Wang (2017). We supplemented the sampling with public and private records of *Bondia* spp., *Commatarcha* spp. and some other related species available in BOLD database (see Acknowledgements). The DNA barcodes of the new species along with the two *Carposina* (*C. scirrhosella*, BOLD:ADJ0833, *C. berberidella*, BOLD:ACG2435) have been deposited in a dataset DS-CARPBOND (dx.doi.org/10.5883/DS-CARPBOND) in the Barcode of Life Database (BOLD) (Ratnasingham and Hebert 2007). The results of DNA analysis of two Romanian specimens, sequenced in the Canadian Centre for DNA Barcoding (CCDB; University of Guelph) using standard protocols, were also stored in this database. We compared the sequence initially with all records accessible to us and then selected a representative of each species and BINs (Barcode Index Numbers) of *Bondia* and *Commatarcha* for further analyses, particularly tree reconstructions. The genetic distance estimations were done using BOLD analytics and the Neighbor Joining and the Maximum likelihood trees were made in MEGA 10.0.5 (Kumar et al. 2016) under the Kimura 2-Parameter model for Neighbor Joining and GTR (General Time Reversible) model for Maximum likelihood. Node supports were estimated based on 500 bootstrap replicates. The Neighbor Joining tree was rooted to *Meridarchis excisa* (Walsingham, 1900) (Carposinidae).

Taxonomy

Commatarcha galicicae Tokár & Srnka, sp. nov.

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Material. ***Holotype*:** North Macedonia: ♀, pinned, genitalia in a separate slide. Original labels: "Macedonia, Galičica Planina, 1570 m, 27–29.vi.2016, lgt. Ľ. Srnka", "Gp. Z. Tokár ♀ 14081", "DNA sample SDNU.ZT_21 BUCCN" (blue label), "HOLOTYPE *Commatarcha galicicae* Tokár & Srnka" (red label), coll. Ľ. Srnka (to be deposited in the National Slovak Museum in Bratislava). Coordinates of the type locality: 40°58'N, 20°51'E.

***Paratypes*:** North Macedonia: 1♀, same locality and data as holotype, Gp. Z. Tokár ♀ 13777, coll. Z. Tokár; 2♂, 2♀, same locality as holotype, 14.vii.2021, Ľ. Srnka leg., Gp. Z. Tokár ♂ 14170, 14171, ♀ 14169, coll. Ľ. Srnka & Z. Tokár; Romania: 2♀, Banat, Dubova, 44°37'N, 22°15'E, 200–300 m, 17.vi.2021, TLMF Lep 32643, TLMF Lep 32675, leg. & coll. S. & Z. Kovács, Gp. Z. Tokár ♀ 14390. All paratypes with red labels "PARATYPE *Commatarcha galicicae* Tokár & Srnka".

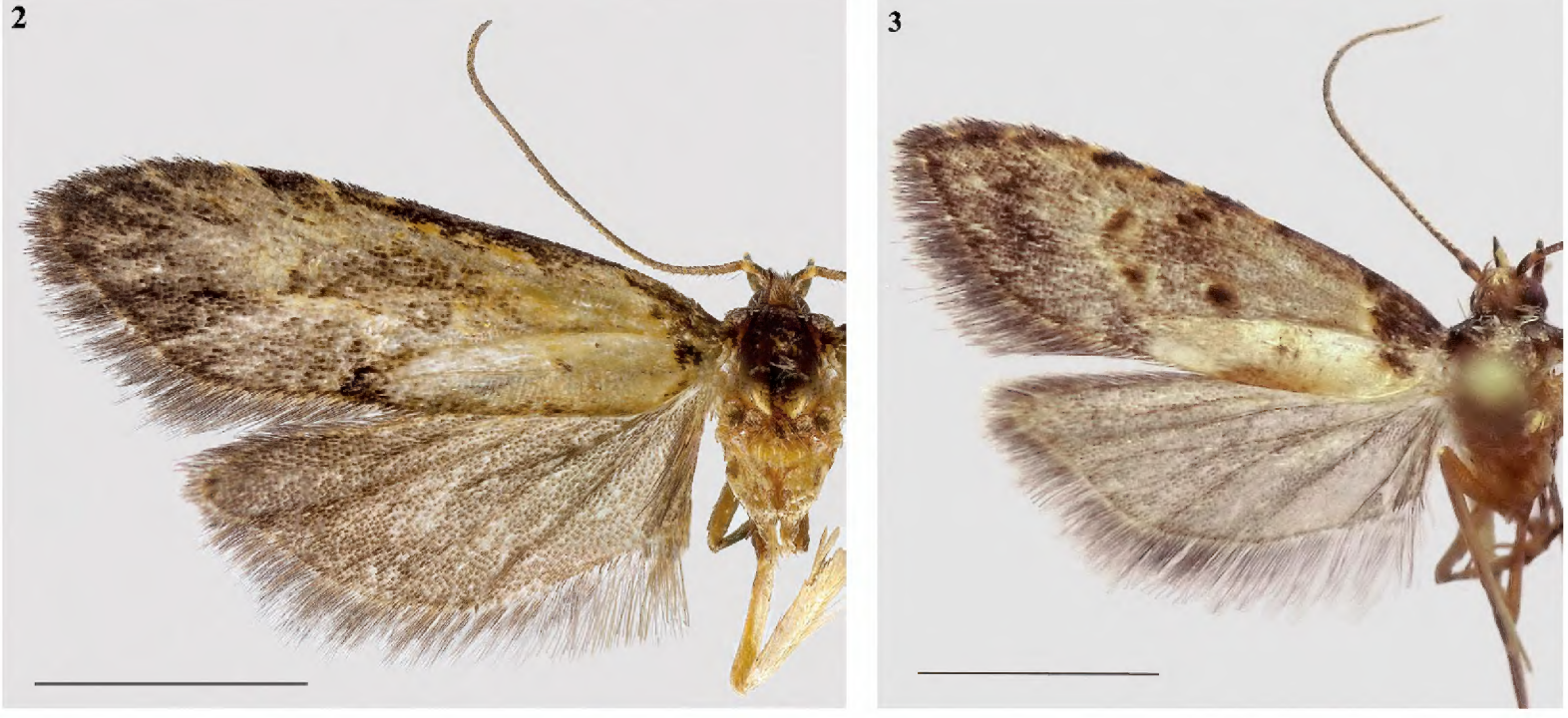
Description. Adult, female (Figs 1, 4). Forewing wingspan 14.5–19 mm, length 6.5–9 mm. Head: frons golden yellow, vertex with golden yellow to light brown scale tufts. Proboscis well-developed. Maxillary palpi not visible. Labial palpi straight, second segment 1¾ times as long as the eye diameter, outer side dark brown, most of the inner surfaces light golden yellow, apical segment short, dark brown, golden yellow at apex. Antennal flagellomeres each ringed alternately dark brown and light golden yellow. Ventral surface of flagellomeres covered with fine sensilla, length approximately half the segment diameter. Thorax tegulae dark brown to black, abdomen the same colour tinged with yellow on some segments. Forewing oblong, gradually widening. Ground colour light yellow to golden yellow. Markings dark brown to black: transverse band at base, extending towards costa, narrow strip along costal margin, irregular band approximately from 1/2 of costa to 2/3 of dorsum with extended part at discal cell pointed towards termen and distinct triangular tornal spot, broad arched band covering outer third of forewing, and small scattered dark spots or scales throughout. Dark markings brightened or interrupted by light spots or groups of scales. Fringe dark brown, yellow basally. Hindwing dark grey, fringe same colour, yellow basally.

Male (Figs 2, 3, 5). Forewing wingspan 14.5–16.5 mm, length 6.5–7.8 mm. Labial palpi and antennae sexually dimorphic. Second segment of labial palpi 1¼ times longer than the eye diameter. Fine, elongate sensilla, covering ventral surface of antennal flagellomeres, length approximately 1.5 times the segment diameter. Forewing markings as female but less pronounced.

Female genitalia (Fig. 6). Ovipositor moderately elongate, lobes soft; apophyses posteriores elongate, approximately 1.6 times length of apophyses anteriores. Abdominal segment VIII moderately sclerotised, covered with long bristles and spinulose; ostium bursae margins curved inwards; antrum cup-shaped, distally covered with small thorns. Sterigma laterally dilated. Sclerotised part of ductus bursae (colliculum) funnel-shaped, slightly concave, widening into a membranous, twisted swelling posterior to a slender, finely papillate area of ductus bursae. Ductus bursae gradually widening to form suboval corpus bursae; signa absent.

Male genitalia (Figs 7, 8). Uncus indistinct, fused to tegumen. Gnathos absent. Valvae broad at base with protuberant lobe, outer half deeply divided into two curved digitate processes of unequal size and width. Medial process slightly shorter but twice as wide and more sclerotised than the lateral process. Ectophallus well-developed, stout and arched. Juxta ellipsoid. Vinculum and saccus well-developed, V-shaped. Phallus slender, vesica with a pair of rows of stout cornuti of various sizes.

Figure 1. *Commatarcha galicicae* Tokár & Srnka, sp. nov., female, holotype, Galičica Planina, 27–29. vi.2016. Scale bar: 3.0 mm.



Figures 2, 3. *Commatarcha galicicae* Tokár & Srnka, sp. nov., males, paratypes, Galičica Planina, 14.vii.2021. Scale bar: 3.0 mm.

Diagnosis. The male and female genitalia of *Commatarcha galicicae* Tokár & Srnka, sp. nov. closely resemble those of *C. oresbia*. The male genitalia of the new species differ from *C. oresbia* mainly in having an indistinct uncus, and the vinculum and saccus wide and V-shaped, whilst in the latter the uncus is a small, sclerotised triangle, and the vinculum and saccus is long and rather slender. In the female genitalia, the new species can be distinguished from *C. oresbia* by the different characters of the ostium and ductus bursae; posterior margin of the ostium bursae and the margins of the colliculum being concave, whilst in *C. oresbia* they are convex.

Figures 4, 5. *Commatarcha galicicae* Tokár & Srnka, sp. nov., heads **4.** Female, holotype, Galičica Planina, 27–29.vi.2016; **5.** Male, paratype, Galičica Planina, 14.vii.2021.

In addition, both species differ significantly from each other in external appearance. Externally the new species is somewhat similar to several Chinese *Commatarcha* species (*C. acidodes*, *C. convoluta*, *C. fanjingshana*), but perhaps the most similar looking species is the American species *Bondia comonana*. However, all these species differ considerably in the structure of the genitalia of both sexes.

Distribution. So far only known from the two localities, the Galičica Mountain, North Macedonia, and Dubova, Banat region, Mehedinţi County, Romania.

Biology. Adults of the new species were on the wing in the second half of June and in July. The habitat of the locality in the Galičica Mountain has a forest-steppe character. We observed the following tree/shrub species there: *Fagus sylvatica* L., *Corylus* sp., *Prunus* sp., *Rubus* sp., *Juniperus* sp., *Acer* sp., *Abies* sp., *Quercus* sp., *Amelanchier* sp., *Aria* sp., and others. This biotope is shown in Fig. 9. It is worth noting that specimens of another carposinid species *Carposina scirrhosella* were found in the same biotope and at the same time as our new species.

The Romanian specimens were collected in a limestone area near Dubova covered with grassy vegetation and plenty of *Syringa* L., and *Cotinus coggygria* Scop. bushes, and the presence of a mixed forest dominated by *Carpinus betulus* L., *Quercus* sp., and also with *Acer campestre* L. (Zoltán and Sándor Kovács pers. comm.).

The biology of *Commatarcha* species is very little known. The life history of *Commatarcha palaeosema* Meyrick, 1935 was described by Yano (1959) from Japan. According to the author the larva of the species feeds under the bark of the trunks and branches of *Castanopsis cuspidata* (Thunb.) Schottky, *Quercus glauca* Thunb., and *Q. serrata* Murray, and considerably injures them producing a remarkable protuberance or gall-like swelling. He observed that usually a number of larvae bore into the same swellings and eject small reddish pellets of frass and woody fragments. Of the closely related American species included in the genus *Bondia*, the best known is *Bondia comonana*, which can form stem galls on *Prunus* or *Quercus* trees (Powell and Opler 2009; Robinson et al. 2010). We can only surmise that the larva of our new species also develops in a similar way in the galls of some tree or shrub species occurring in the type localities.

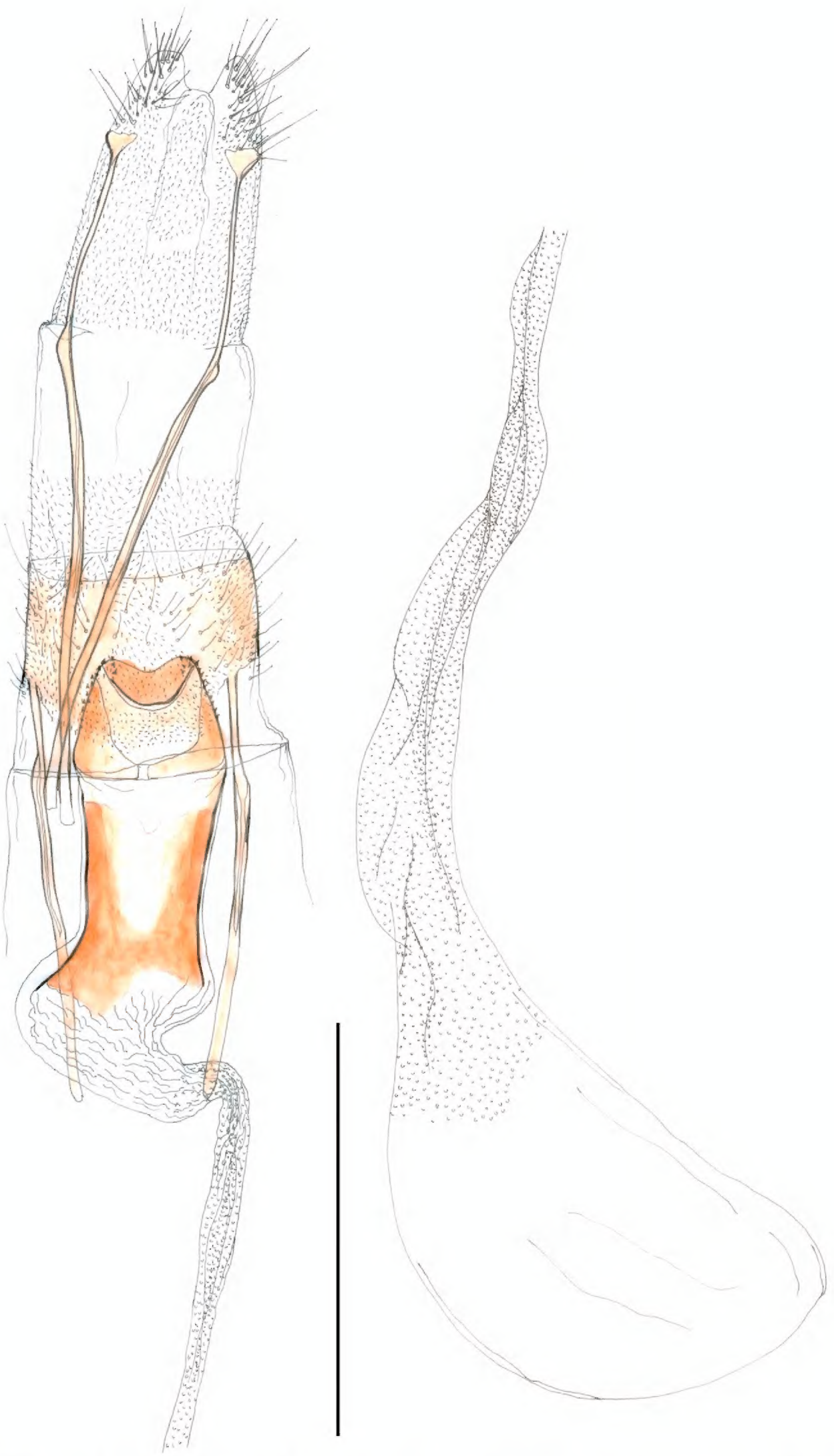
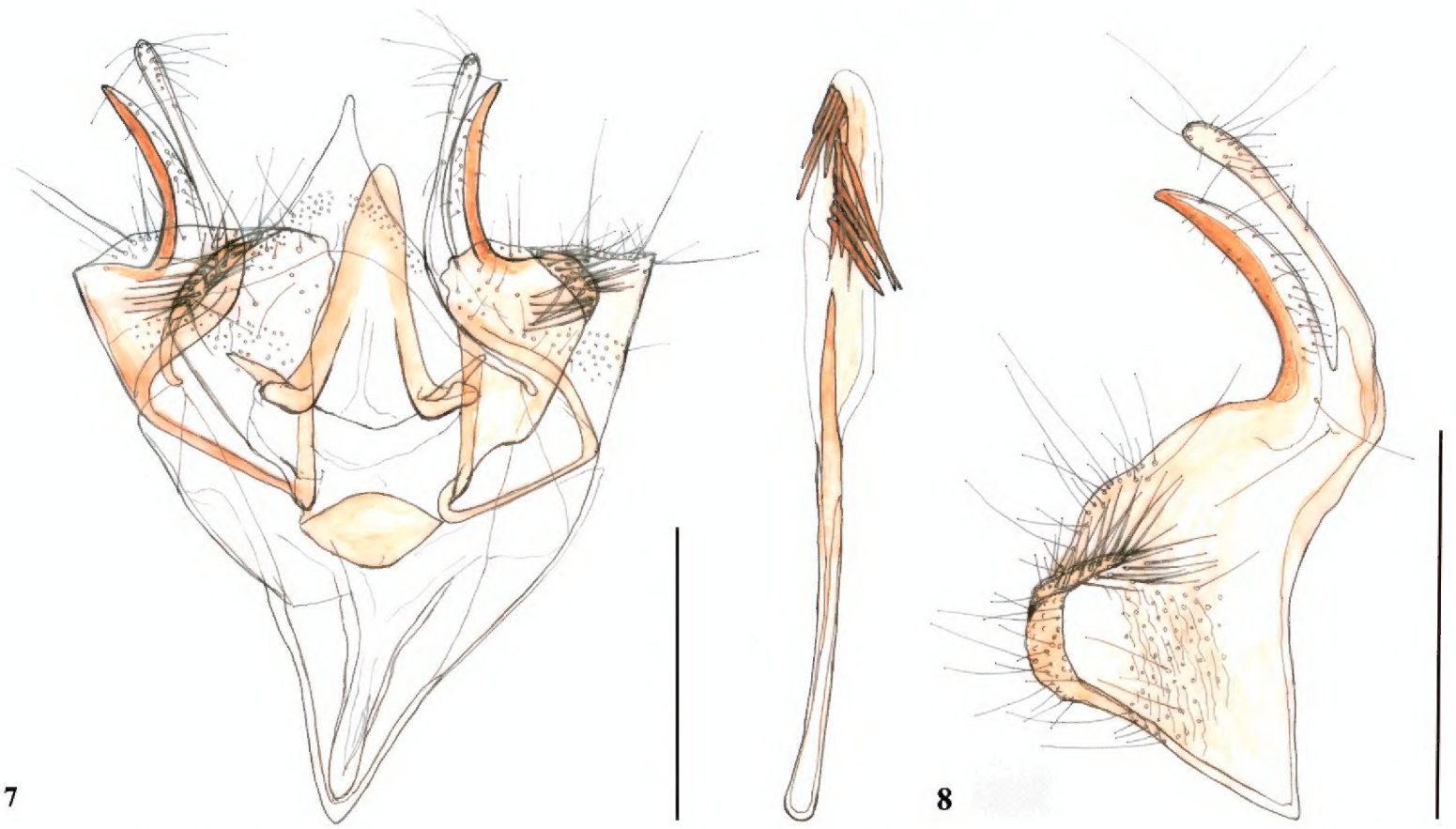


Figure 6. Female genitalia of *Commatarcha galicicae* Tokár & Srnka, sp. nov., paratype, Gp. Z. Tokár ♀ 13777, dorsal view. Scale bar: 1.0 mm.



Figures 7, 8. Male genitalia of *Commatarcha galicicae* Tokár & Srnka, sp. nov., paratypes **7.** Gp. Z. Tokár ♂ 14170, dorsal view. Scale bar: 0.5 mm; **8.** Gp. Z. Tokár ♂ 14171, valva. Scale bar 0.5 mm.

Figure 9. Type-locality of *Commatarcha galicicae* Tokár & Srnka, sp. nov. in the Galičica Mountain.

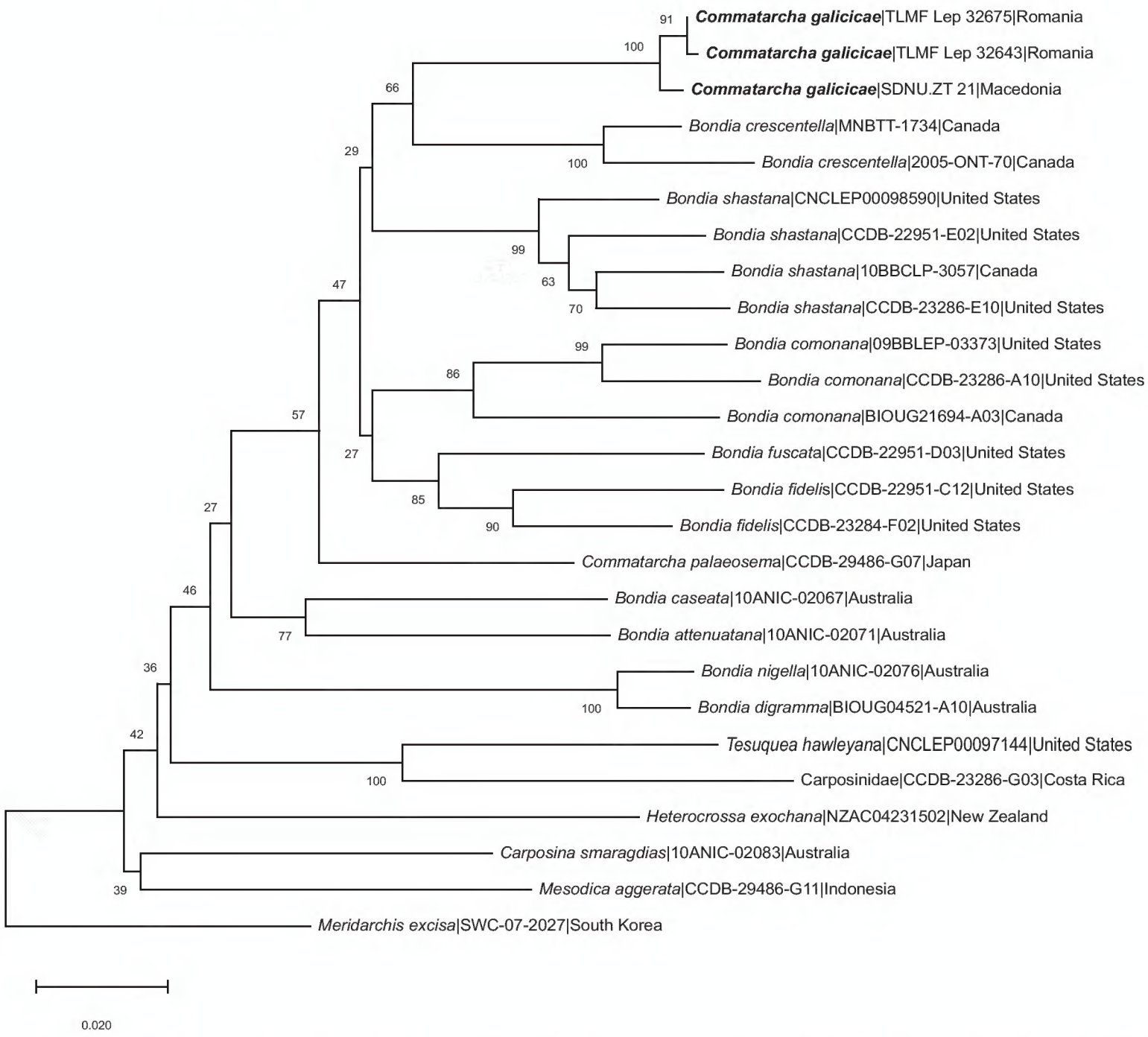


Figure 10. A Neighbor Joining tree of *Commatarcha galicicae* Tokár & Srnka, sp. nov. (shown in bold face) and selected closely related species based on COI sequences. Numbers are bootstrap percentages. Scale bar represents 2% K2P genetic divergence between sequences.

Etymology. The specific name *galicicae*, a noun in the genitive case, is derived from the Galičica Mountain, where the first specimens of the new species were discovered.

Molecular data (Figs 10, 11). The DNA barcoded specimens form a unique BIN: BOLD:AEH8633. Sequences in this BIN are highly divergent to other BINs with a minimum p-distance of 8.05% to the closest BIN (*Bondia crescentella* (Walsingham, 1882)). The Macedonian specimen shows 4–5 nucleotide substitutions compared to the two Romanian specimens, which differ from each other by one substitution.

Discussion. As mentioned in the Introduction, the Palaearctic *Commatarcha* species are very close to American *Bondia* species morphologically. According to the molecular data, these two genera are closely related but not reciprocally monophyletic in the Maximum likelihood tree, although this finding is based on a single mitochondrial marker only. None of the analyses based on COI-5P show threshold support (e.g. >70% bootstrap) for major geographic clusters. However,

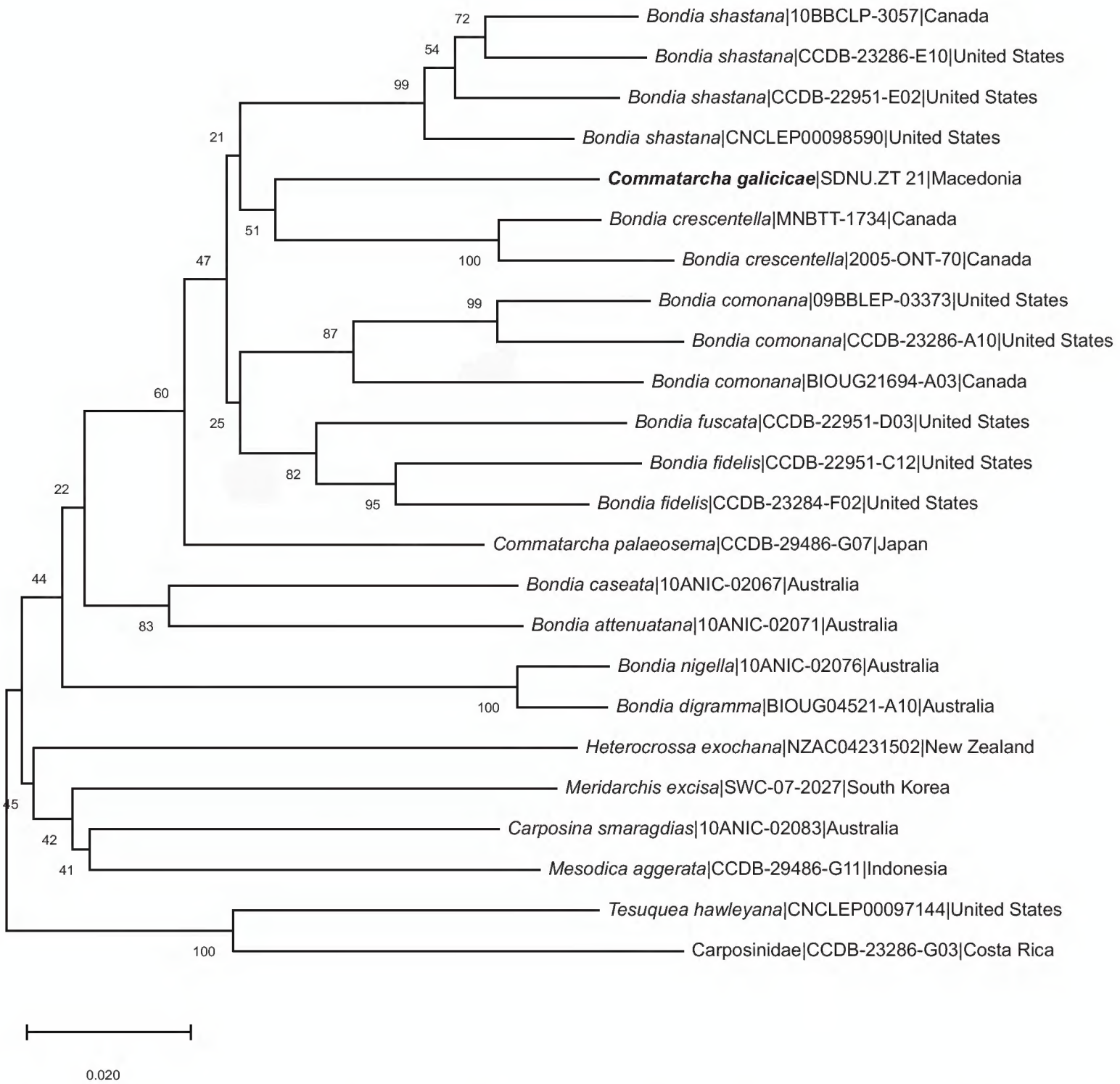


Figure 11. A Maximum Likelihood tree of *Commatarcha galicicae* Tokár & Srnka, sp. nov. (shown in bold face) and selected closely related species based on COI sequences. Numbers are bootstrap percentages. Scale bar represents 2% difference (GTR model) between sequences.

for species of *Commatarcha* very little genetic data are available, for which reason confirmation of this observation should be verified by broader genetic and taxonomic sampling. It was the incomplete sampling of *Commatarcha* and genetic similarity of the American species of *Bondia* that led us in the wrong direction when we initially placed our new species in the genus *Bondia*. Only a more thorough comparison of male and female genitalia of *C. galicicae* Tokár & Srnka, sp. nov. showed that is actually morphologically closer to some Asiatic species of *Commatarcha*. Generally, species of Palaearctic *Commatarcha* and American *Bondia* have many morphological features in common, including sexually dimorphic antennae, the uncus of the male genitalia with a small conical lobe, the absence of a gnathos, the valva with processes, a well developed and

usually arched ectophallus and the female genitalia with a heavily sclerotized colliculum and signa absent. By contrast, the Australian *B. nigella*, the type species of the genus, has the valva without processes in the male genitalia and the corpus bursae with signa in the female genitalia, representing significant differences from the above mentioned groups. Moreover, Australian *Bondia* species form a separate cluster in the DNA barcoding trees (Figs 10, 11). Davis (1969) considered that it may be decided after an adequate study of all the species has been completed that the Australian species and North American species of *Bondia* require separate generic or subgeneric placements but he did not have sufficient data to change their generic position at that time. Diakonoff (1989) showed on morphological grounds that Asiatic species, previously placed in the genus *Bondia*, are not congeneric with the Australian type species, and moved them all to *Commatarcha*. He also supported Davis' doubts about the similarities of *Bondia* from the American and Australian continents but this was not followed up with taxonomic actions. According to current knowledge we are convinced that the Palaearctic *Commatarcha* and American *Bondia* groups are congeneric and therefore a comprehensive revision of Australian and American *Bondia* species would be required.

The discovery of *Commatarcha galicicae* Tokár & Srnka, sp. nov. shows that the fauna of the Galičica Mountain is still insufficiently studied and can provide discoveries of hitherto unknown species. For example, the new species *Platyptilia galicicaensis* has recently been described from there (Junnilainen and Kaitila 2017). Galičica is characterized by a high incidence of endemic plants (Matevski et al. 2011), which also indicates the presence of endemic insect species there. After the first discovery, we assumed that our new species might be endemic to this area. However, the subsequent findings in south-western Romania point to a wider distribution of the species. The question arises as to whether *C. galicicae* represents another newly introduced or recently spread species from the regions of Western or Central Asia, or if it is an "old" European species that had remained undiscovered until now. The two nearly simultaneous discoveries from two different areas in the same year suggest that the species is a recent addition to the fauna of this region.

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